

**Table I: Voxel Input Data Elements (VIDE).** A description of VIDE, and the initial preferences used to generate the input VIDE vectors, are in section 1.2. These preferences resulted in efficient adaptation of the input data to feature clusters representing the soft tissue face or skull.

Element	Description of Voxel Input Data Element (VIDE)	Default Weighting
$\xi_1, E_{dh}$	Euclidean distance from volume centroids	$\kappa_1 = 100\%$
$\xi_2, V_i$	Voxel density from input image volume	$\kappa_2 = 100\%$
$\xi_3, g$	Gaussian computed with predefined	$\kappa_3 = 80\%$
$\xi_4, g_d$	Difference of Gaussian computed with	$\kappa_4 = 80\%$
$\xi_5, Z_c$	Laplacian Zero Crossing	$\kappa_5 = 80\%$
$\xi_6, m_i$	Invariant Image Moments	$\kappa_6 = 10\%$

**Table II: Volume differences for soft tissue face surface segmentation for each method.** Within-method difference value is between each session and the average. Between-method difference is between both averages. Manual segmentation was done in the AUTO program. Image volume units are mm<sup>3</sup>.

Specimens:		B2537	B2621	B3037	B3094	B3195	Average
Manual Slice based method	Session1	4454.47	3878.77	4044.76	4139.61	4068.59	0.34 0.008%
	Session2	4455.89	3878.35	4045.00	4130.43	4069.84	
	Average	4455.18	3878.56	4044.88	4130.52	4069.22	
	Difference	0.71	0.20	0.11	0.09	0.62	
	% of Var	0.015%	0.005%	0.002%	0.002%	0.015%	
SOFM	Session1	4467.72	3930.26	4044.84	4175.78	4066.37	0.33 0.007%
	Session2	4467.72	3930.26	4044.84	4177.45	4066.37	
	Average	4467.72	3930.26	4044.84	4176.62	4066.37	
	Difference	0.0	0.0	0.0	1.67	0.0	
	% of Var	0%	0%	0%	0.039%	0%	
Manual Versus SOFM	Average Difference	12.54	51.91	0.04	46.10	2.84	22.68
	% of Var	0.281%	1.329%	0%	0.989%	0.069%	0.534%

TABLE III

		B2537	B2621	B3037	B3094	B3094	average
Manual Slice- based method	Session1	1130.08	1298.25	1333.19	1193.54	1323.37	
	Session2	1167.12	1288.55	1383.41	1162.61	1312.27	
	Average	1148.60	1293.40	1358.30	1178.08	1317.82	
	Difference	37.03	9.30	50.21	39.93	11.10	29.51
	% of Var	3.223%	0.719%	3.696%	3.389%	0.842%	2.373%
SOFM	Session1	1104.77	1303.32	1401.02	1264.54	1251.83	
	Session2	1126.60	1317.74	1401.02	1273.90	1251.31	
	Average	1115.68	1310.53	1401.02	1269.22	1251.57	
	Difference	21.82	14.42	0.0	9.36	0.52	9.22
	% of Var	1.955%	1.100%	0%	0.737%	0.041%	0.766%
Manual versus SOFM	Average Difference	32.92	17.13	42.71	91.14	66.24	50.03
	% of Var	2.906%	1.283%	3.095%	7.448%	5.156%	3.396%

TABLE IV

LANDMARKS	2D RELIABILITY AVER MSE S.D	SOFM RELIABILITY AVER MSE S.D	2D vs. SOFM PRECISION AVER MSE S.D
01. Glabella	0.106 0.071 0.067	0.012 0.011 0.011	1.301 0.463 0.439
02. Sellion	0.191 0.108 0.103	0.010 0.006 0.006	1.194 0.396 0.375
03. Pronasale	0.206 0.157 0.149	0.010 0.009 0.008	0.610 0.455 0.432
04. Subnasale	0.192 0.171 0.162	0.015 0.009 0.009	1.524 0.704 0.668
05. Labiale superius	0.395 0.259 0.246	0.017 0.009 0.009	0.712 0.551 0.522
06. Stomion	0.340 0.227 0.215	0.018 0.020 0.019	0.796 0.358 0.339
07. Labiale inferius	0.181 0.139 0.132	0.016 0.018 0.017	0.971 0.491 0.465
08. Sublabiale	0.402 0.287 0.272	0.012 0.007 0.007	0.890 0.566 0.537
09. Pogonion	0.229 0.231 0.219	0.016 0.010 0.009	2.804 0.738 0.700
10. Ganthion	0.212 0.190 0.189	0.011 0.013 0.012	1.442 0.948 0.899
11. R. Gonion	0.234 0.103 0.098	0.017 0.014 0.013	3.307 1.190 1.129
12. L. Gonion	0.196 0.101 0.096	0.018 0.014 0.013	2.642 1.070 1.015
13. R. Otobasion infer	0.097 0.037 0.035	0.013 0.010 0.009	2.044 1.804 1.711
14. L. Otobasion infer	0.147 0.096 0.091	0.016 0.010 0.009	1.350 0.639 0.606
15. R. Otobasion sup	0.194 0.139 0.132	0.017 0.021 0.020	1.631 0.515 0.489
16. L. Otobasion sup	0.207 0.127 0.120	0.019 0.018 0.017	1.295 0.724 0.687
17. R. Superaurale	0.211 0.189 0.180	0.010 0.007 0.007	1.487 0.655 0.622
18. L. Superaurale	0.118 0.083 0.079	0.010 0.006 0.006	1.274 0.640 0.607
19. R. Subaurale	0.245 0.159 0.151	0.011 0.007 0.006	2.124 0.756 0.717
20. L. Subaurale	0.271 0.244 0.232	0.020 0.016 0.015	1.742 1.377 1.307
21. Inferior Pronasale	0.280 0.179 0.170	0.018 0.016 0.015	1.188 0.800 0.759
Average	0.222 0.157 0.149	0.015 0.012 0.011	1.540 0.754 0.716

TABLE V

LANDMARKS	2D RELIABILITY AVER MSE S.D	SOFM RELIABILITY AVER MSE S.D	2D vs. SOFM PRECISION AVER MSE S.D
01. Basion	0.917 1.039 0.986	0.384 0.385 0.365	1.211 0.581 0.549
02. R. Porion	0.742 0.369 0.350	0.151 0.115 0.109	1.311 0.594 0.564
03. L. Porion	0.877 0.676 0.641	0.279 0.118 0.112	1.154 0.581 0.551
04. Nasion	0.359 0.208 0.197	0.175 0.106 0.101	1.560 0.778 0.738
05. R. Supraorbital	0.303 0.256 0.243	0.142 0.093 0.089	0.924 0.484 0.459
06. L. Supraorbital	0.459 0.141 0.134	0.132 0.097 0.092	1.119 0.700 0.664
07. R. Medial Orbit	0.502 0.253 0.240	0.158 0.082 0.078	2.094 0.709 0.672
08. L. Medial Orbit	0.761 0.400 0.380	0.252 0.208 0.198	1.642 0.634 0.602
09. R. Lateral Orbit	0.967 0.731 0.693	0.257 0.211 0.200	1.700 0.631 0.599
10. L. Lateral Orbit	0.801 0.887 0.842	0.154 0.129 0.122	1.543 0.704 0.668
11. R. Orbital	0.639 0.683 0.645	0.158 0.122 0.115	1.357 0.680 0.645
12. L. Orbital	0.921 0.900 0.854	0.304 0.182 0.173	1.573 0.721 0.684
13. Ant.Nasal Spine	0.389 0.409 0.388	0.075 0.033 0.031	3.048 2.385 2.262
14. A Point	0.498 0.317 0.301	0.059 0.021 0.020	1.983 2.128 2.019
15. Supradentale	0.676 0.630 0.598	0.195 0.226 0.215	0.773 0.299 0.283
16. Upper Inc.Edge	0.463 0.257 0.244	0.186 0.246 0.233	1.037 0.808 0.766
17. Lower Inc.Edge	0.743 0.568 0.539	0.197 0.208 0.197	1.768 0.694 0.659
18. Infradentale	1.027 1.044 0.990	0.140 0.088 0.084	1.373 0.861 0.817
19. B Point	0.768 0.480 0.455	0.211 0.221 0.209	1.430 0.855 0.811
20. Pogonion	1.016 1.026 0.973	0.095 0.041 0.038	1.270 0.532 0.504
21. Menton	0.701 0.489 0.464	0.149 0.136 0.129	1.131 0.680 0.645
22. R. Gonion	0.888 0.693 0.657	0.129 0.078 0.074	1.428 0.494 0.469
23. L. Gonion	0.926 0.973 0.923	0.200 0.105 0.100	2.189 1.626 1.543
24. R. Ant Cond.Pol	2.170 1.951 1.851	0.295 0.077 0.073	2.883 2.502 2.373
25. L. Lat Cond.Pol	2.195 1.886 1.789	0.194 0.114 0.108	2.338 1.163 1.104
26. Rhinion	0.983 1.027 0.974	0.280 0.168 0.159	1.593 0.974 0.924
Average	0.834 0.704 0.667	0.190 0.139 0.132	1.609 0.929 0.881

SOFT TISSUE FACE LANDMARKS		
1.glabella	20.r_labialeSuperiusl	39.r_otobasionSuperius
2.r_superciliare	21.l_labialeSuperiusl	40.l_otobasionSuperius
3.l_superciliare	22.r_cheilion	41.r_tragion
4.r_antFrontoTemporal	23.l_cheilion	42.l_tragion
5.l_antFrontoTemporal	24.stomion	43.r_inferiorTragion
6.r_palpreSuperius	25.labialeInferius	44.l_inferiorTragion
7.l_palpreSuperius	26.sublabiale	45.r_superiorAntihelix
8.r_endocanthion	27.pogonion	46.l_superiorAntihelix
9.l_endocanthion	28.gnathion	47.r_antSupLongAxis
10.r_exocanthion	29.r_tuberculare	48.l_antSupLongAxis
11.l_exocanthion	30.l_tuberculare	49.r_supLatTragion
12.r_palpreInferius	31.r_gonion	50.l_supLatTragion
13.l_palpreInferius	32.l_gonion	51.r_infLatTragion
14.sellion	33.r_otobasionInferius	52.l_infLatTragion
15.pronasal	34.l_otobasionInferius	53.r_inferiorAntihelix
16.r_alare	35.r_subAurale	54.l_inferiorAntihelix
17.l_alare	36.l_subAurale	55.r_lateralSubalare
18.subnasale	37.r_superaurale	56.l_lateralSubalare
19.labialeSuperius	38.l_superaurale	

TABLE VII

SKULL LANDMARKS		
1.r_upper_molar	19.l_ant_inf_inf_zygoma	37.r_lower_molar
2.l_upper_molar	20.r_porion	38.l_lower_molar
3.upper_inc_edge	21.l_porion	39.lower_inc_edge
4.tip_of_nose_Rhinion	22.nasion	40.r_coronoid
5.ANS	23.r_base_of_coronoid	41.l_coronoid
6.r_lacrimale	24.l_base_of_coronoid	42.r_condylion
7.l_lacrimale	25.r_lat_pir_ap	43.l_condylion
8.r_inf_lat_orb_corner	26.l_lat_pir_ap	44.r_gonion
9.l_inf_lat_orb_corner	27.r_optic_foramen	45.l_gonion
10.r_sup_lat_orb_corner	28.l_optic_foramen	46.menton
11.l_sup_lat_orb_corner	29.r_tip_sup_orb_fissure	47.mid_sup_nuchal_line_pt
12.r_sup_medial_orb_corner	30.l_tip_sup_orb_fissure	48.r_posterior_boss_pt,
13.l_sup_medial_orb_corner	31.r_tip_inf_orb_fissure	49.l_posterior_boss_pt
14.r_ant_inf_sup_zygoma	32.l_tip_inf_orb_fissure	50.r_anterior_boss_pt
15.l_ant_inf_sup_zygoma	33.r_post_tip_inf_orb_fissure	51.l_anterior_boss_pt
16.r_ant_sup_sup_zygoma	34.l_post_tip_inf_orb_fissure	52.coronal_sagittal_intersection
17.l_ant_sup_sup_zygoma	35.r_lo_porion	53.r_pterygomaxillary_point
18.r_ant_inf_inf_zygoma	36.l_lo_porion	54.l_pterygomaxillary_point

*Table VIII* Cost Function Features

Components for cost functions for simulated annealing (Section 4D). The first, second, and third order derivatives are computed from the segmented surface voxel data in the volume image after [34].

	Ridge Curve	Tiling Curve
1	Gaussian $K = k_1 \cdot k_2$	Gaussian $K = k_1 \cdot k_2$
2	Mean $H = \frac{1}{2}\{k_1 + k_2\}$	Mean $H = \frac{1}{2}\{k_1 + k_2\}$
3	$I_{xxx}$	$I_{xxx}$
4	$I_{xxy}$	$I_{xxy}$
5	$I_{xxz}$	$I_{xxz}$
6	$I_{xyy}$	$I_{xyy}$
7	$I_{xyz}$	$I_{xyz}$
8	$I_{xzz}$	$I_{xzz}$
9	$I_{yyy}$	$I_{yyy}$
10	$I_{yyz}$	$I_{yyz}$
11	$I_{yzz}$	$I_{yzz}$
12	$I_{zzz}$	$I_{zzz}$
13		$d_m$

**Table IX** Root Mean Square of distances between sessions with SASE Method

Square root of sum of the squared differences for the soft tissue face surface extractions are within 0.5 mm, whereas skull surface extractions show more than 1 mm differences. The differences are mainly due to the false signals from oro-dental artefact and thin bone in the orbital regions.

	Soft Tissue Face Surfaces	Boney Skull Surfaces
B2537	0.315 mm	0.551 mm
B2558	0.330 mm	0.675 mm
B2621	0.428 mm	0.572 mm
B3094	0.102 mm	0.652 mm
B3195	0.312 mm	0.606 mm
Average	0.360 mm	0.611 mm





**Table XIA: Tile-by-Tile Summary of Error Distribution Between Methods for Soft Tissue Face Surfaces, in mm.**

The same results as in Table 4 presented tile by tile. See Figure 2 and Appendix 1 for tile location. See Figure 16 for graphical depiction of within and between tile error distribution in both methods.

		NYU	SASE			NYU	SASE
1	Patch_01	6.195	0.681	23	Patch_25	5.976	0.442
2	Patch_02	6.230	0.502	24	Patch_26	5.983	0.437
3	Patch_03	6.242	0.619	25	Patch_27	6.063	0.411
4	Patch_04	6.244	0.497	26	Patch_28	5.834	0.398
5	Patch_05	6.237	0.598	27	Patch_29	5.811	0.387
6	Patch_06	6.240	0.480	28	Patch_30	5.962	0.573
7	Patch_07	6.090	0.591	29	Patch_31	6.043	0.437
8	Patch_08	6.000	0.556	30	Patch_32	6.137	0.579
9	Patch_09	6.064	0.577	31	Patch_33	5.984	0.397
10	Patch_10	6.139	0.468	32	Patch_34	6.162	0.394
11	Patch_11	6.165	0.428	33	Patch_35	5.863	0.400
12	Patch_12	6.239	0.461	34	Patch_36	5.863	0.449
13	Patch_13	6.198	0.471	35	Patch_37	5.990	0.485
14	Patch_14	5.849	0.518	36	Patch_38	5.704	0.555
15	Patch_15	6.169	0.463	37	Patch_39	6.190	0.427
16	Patch_16	6.036	0.473	38	Patch_40	6.170	0.431
17	Patch_17	5.715	0.440	39	Patch_41	6.241	0.393
18	Patch_20	5.951	0.479	40	Patch_42	6.232	0.420
19	Patch_21	5.828	0.436	41	Patch_43	6.241	0.401
20	Patch_22	5.934	0.518	42	Patch_44	6.247	0.404
21	Patch_23	5.354	0.401	43	Patch_45	6.238	0.477
22	Patch_24	5.532	0.475	44	Patch_46	6.245	0.391
	<b>AVERAGE</b>	<b>6.025</b>	<b>0.473</b>				

**Table XI B: Tile-by-Tile Summary of Error Distribution Between Methods for Skull Surfaces, in mm.**

The same results as in Table 4 presented tile by tile. See Figure 2 and Appendix 1 for tile location. See Figure 16 for graphical depiction of within and between tile error distribution in both methods.

		NYU	SASE			NYU	SASE
	l_ant_maxilla.1	3.640	0.358		r_zygoma.2	3.122	0.372
	l_ant_maxilla.2	2.428	0.365		r_zygoma.3	5.885	0.358
	l_ant_maxilla.3	2.812	0.393		r_lat_skull_quad	8.886	0.353
	l_ant_maxilla.4	4.947	0.516		closed_tri_orbits	8.174	0.389
	l_lateral_nose	3.791	0.487		top_of_head.1	9.527	0.331
	l_orbit.1	3.342	0.541		top_of_head.2	4.829	0.328
	l_orbit.2	2.884	0.431		top_of_head.3	9.809	0.344
	l_orbit.3	5.188	0.484		top_of_head.4	6.360	0.327
	l_orbit.4	5.100	0.754		top_of_head.5	6.311	0.346
	l_zygoma.1	4.074	0.723		top_of_head.8	9.790	0.439
	l_zygoma.2	5.749	0.545		top_of_head.9	8.693	0.677
	l_zygoma.3	5.259	0.592		top_of_head.10	7.014	0.525
	l_lateral_skulquad	8.317	0.643		top_of_head.11	8.338	0.546
	r_ant_maxilla.1	3.301	0.691		back_of_head.1	6.893	0.476
	r_ant_maxilla.2	2.762	0.494		back_of_head.2	8.364	0.394
	r_ant_maxilla.3	3.615	0.500		back_of_head.3	7.686	0.447
	r_ant_maxilla.5	2.845	0.507		l_pterygomaxillar	8.048	0.390
	r_lateral_nose	3.145	0.492		l_mandible.1	6.282	0.400
	r_orbit.1	3.315	0.520		l_mandible.2	8.137	0.428
	r_orbit.2	3.744	0.406		l_mandible.3	7.007	0.438
	r_orbit.3	2.855	0.428		r_mandible.1	6.282	0.443
	r_orbit.4	2.495	0.379		r_mandible.2	5.211	0.381
	r_zygoma.1	4.011	0.386		r_mandible.3	7.121	0.459
	<b>Average:</b>	<b>6.295</b>	<b>0.460</b>				

<b>Table XIV Root Mean Square Error Differences of Warped Average Tile Points to Its Member Surface Tile Points in Both Methods:</b> The point-to-point sum of squared differences between the warped average and it's member surface tile points is taken as overall variance for both methods. A thin plate spline warp of the average surface to each sample member is made via Type II landmark configurations. We observe uniform results within both methods.			
		NYU	SSA
Soft Tissue Face	B2537	5.898 mm	0.451 mm
	B2558	6.208 mm	0.451 mm
	B2621	6.116 mm	0.448 mm
	B3094	6.096 mm	0.444 mm
	B3195	6.070 mm	0.449 mm
	Average	6.077 mm	0.448 mm
Boney Skull	B2537	5.915 mm	0.414 mm
	B2558	6.088 mm	0.423 mm
	B2621	5.974 mm	0.418 mm
	B3094	5.921 mm	0.419 mm
	B3195	5.962 mm	0.423 mm
	Average	5.972 mm	0.419 mm

		NYU	SASE			NYU	SASE
1	Patch_01	6.219	0.382	23	Patch_25	6.063	0.433
2	Patch_02	6.241	0.428	24	Patch_26	6.155	0.367
3	Patch_03	6.242	0.395	25	Patch_27	6.075	0.489
4	Patch_04	6.241	0.400	26	Patch_28	6.139	0.403
5	Patch_05	6.232	0.338	27	Patch_29	6.209	0.447
6	Patch_06	6.234	0.397	28	Patch_30	6.130	0.426
7	Patch_07	6.170	0.351	29	Patch_31	6.170	0.441
8	Patch_08	6.028	0.440	30	Patch_32	6.188	0.432
9	Patch_09	6.025	0.477	31	Patch_33	6.114	0.490
10	Patch_10	6.209	0.556	32	Patch_34	5.841	0.445
11	Patch_11	6.185	0.390	33	Patch_35	5.689	0.445
12	Patch_12	6.242	0.410	34	Patch_36	6.009	0.405
13	Patch_13	6.240	0.352	35	Patch_37	5.413	0.441
14	Patch_14	5.933	0.392	36	Patch_38	6.202	0.473
15	Patch_15	6.236	0.510	37	Patch_39	6.215	0.595
16	Patch_16	6.086	0.479	38	Patch_40	6.252	0.534
17	Patch_17	5.870	0.515	39	Patch_41	6.235	0.527
18	Patch_20	5.996	0.443	40	Patch_42	6.241	0.519
19	Patch_21	5.900	0.344	41	Patch_43	6.257	0.510
20	Patch_22	6.014	0.411	42	Patch_44	6.240	0.513
21	Patch_23	5.681	0.391	43	Patch_45	6.243	0.500
22	Patch_24	5.775	0.433	44	Patch_46	6.246	0.630
	<b>AVERAGE</b>	<b>6.078</b>	<b>0.449</b>				

**Table X11/8: Tile-by-Tile Summary of Error Distribution Between Methods for Skull Surfaces, in mm.:** Average surface is warped to each sample member's Type II landmarks on the segmented voxel surface as in Table 2. The differences between the sample member segmented voxel surfaces and the average surface is computed. Tile by tile summary is presented. See Figure 2 and Appendix 1 for tile location. See Figure 8 for depiction of within and between tile error distribution in both methods.

	NYU	SASE		NYU	SASE
l_ant_maxilla.1	5.937	0.360	r_zygoma.2	6.183	0.337
l_ant_maxilla.2	5.856	0.411	r_zygoma.3	6.184	0.355
l_ant_maxilla.3	6.020	0.301	r_lat_skull_quad	5.804	0.327
l_ant_maxilla.4	6.212	0.356	closed_tri_orbits	6.121	0.453
l_lateral_nose	6.220	0.433	top_of_head.1	5.747	0.340
l_orbit.1	6.219	0.388	top_of_head.2	6.025	0.510
l_orbit.2	6.232	0.372	top_of_head.3	6.199	0.452
l_orbit.3	6.212	0.354	top_of_head.4	6.227	0.480
l_orbit.4	6.213	0.386	top_of_head.5	6.208	0.516
l_zygoma.1	6.218	0.406	top_of_head.8	6.217	0.392
l_zygoma.2	6.230	0.445	top_of_head.9	6.185	0.636
l_zygoma.3	5.726	0.471	top_of_head.10	6.152	0.621
l_lateral_skulquad	5.509	0.456	top_of_head.11	6.129	0.586
r_ant_maxilla.1	6.231	0.606	back_of_head.1	5.352	0.542
r_ant_maxilla.2	6.213	0.433	back_of_head.2	4.975	0.578
r_ant_maxilla.3	6.214	0.332	back_of_head.3	5.042	0.675
r_ant_maxilla.5	6.214	0.311	l_pterygomaxillar	5.881	0.447
r_lateral_nose	6.207	0.337	l_mandible.1	5.874	0.304
r_orbit.1	6.194	0.295	l_mandible.2	5.699	0.436
r_orbit.2	6.175	0.311	l_mandible.3	5.959	0.443
r_orbit.3	6.172	0.328	r_mandible.1	5.495	0.481
r_orbit.4	6.213	0.305	r_mandible.2	5.531	0.392
r_zygoma.1	5.984	0.353	r_mandible.3	5.621	0.338
Average:	5.973	0.420			